Computer Sciences Corporation
Capabilities

Computer Sciences Corporation

Capabilities and Composition

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Corporate
Clockwise
Fletcher Jo
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Roy Nutt,

Introduction

☐ Computer Sciences Corporation is the most dynamic organization in the most exciting field of our time—the Information Sciences. This burgeoning field is in its infancy, and its potential is so great it is inestimable. This book is designed to illustrate the scope and depth of the company's present capabilities in the Information Sciences, and to provide an indication of its future direction in this vital new field. ☐ The company has four principal operating entities: the Computer Sciences Division, the Communication Systems Division, the System Sciences Division, and the Politz Research Division. All are wholly-owned subsidiaries, but are designated divisions because of the close coordination of their activities at the corporate level. Any combination of divisions may be called upon for an integrated effort to solve problems and create systems requiring a multi-disciplined approach. ☐ The company has had a dramatic, purposeful growth. At its inception in 1959, there were five employees; today the total exceeds 2,000, most of whom are professional personnel with substantial records of achievement. The company began operations in a single office; now it has a network of installations extending from the West Coast of the United States to West Germany. Revenues have risen from $230,000 in 1959 to $24,000,000 in fiscal 1966. ☐ This

Corporate officers and staff, Computer Sciences Corporation
Clockwise from bottom:
Fletcher Jones, President and Chairman
D. K. Layser, Vice President—Finance
Richard F. Roper, Director, Public Relations and Advertising
Roy H. Lynn, Lt. General (USAF-Ret.), Vice President
Roy Nutt, Vice President

Introduction

growth has proceeded according to management's plan for the systematic development of a total capability in the Information Sciences, a field consisting of four areas of operation: ☐ **Data Gathering**—Collection of data by electronic or electromechanical equipment, or by human effort. ☐ **Data Organizing**—Arrangement of data into workable form and storage of data in a system combining compactness with ready accessibility. ☐ **Data Processing**—Analysis and electronic manipulation of data to provide information of a specified nature. ☐ **Data Communication**—Transmission of data between source, processor, and user. ☐ At the outset, the company concentrated its efforts in the area of data processing, through the operating entity now known as the Computer Sciences Division. The division is the leading independent developer of systems software—the basic programs which facilitate the operation of computers and control peripheral data processing equipment. Computer Sciences also provides consultation, problem analysis and applications programming for computer users. ☐ Still another Computer Sciences activity is the operation of service bureaus which are equipped with the most powerful computers available. The division pioneered the concept of the remote access service

bureau, making its computers available to data processing clients many miles away via standard telephone circuits. □ Anticipating the now apparent trend toward combined computer-communication systems, the company further broadened its capabilities by acquiring two well-established firms in the data communication field; these organizations are now designated the Communication Systems Division and the System Sciences Division. Their experience ranges from the design of standard voice-oriented telephone systems to the most complicated and advanced communications and aerospace systems. □ More recently, the company acquired Alfred Politz Research, Inc., thereby entering the area of data gathering and analysis. Politz is a leader in the field of marketing research, which is making increasing use of computers and the techniques of data processing. □ Thus, by integrating the disciplines of data processing, data communication, and data gathering and analysis, Computer Sciences Corporation has become the largest independent organization in the Information Sciences. The company will continue to expand, both from within and by acquisition, to enhance its present skills and develop new capabilities. □ In the following pages, the capabilities of the four divisions are described in greater detail.

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George E. Brown

Computer Sciences Division

☐ The company's Computer Sciences Division is the leading independent organization in the largest and fastest-growing segment of the data processing industry—the field of systems analysis, computer programming and related services. The division has provided its services to every major manufacturer of electronic data processing equipment in the United States and to hundreds of computer users here and abroad. Its clients include industrial and commercial organizations as well as civil and military agencies of the U.S. Government. ☐ Computer Sciences applies its problem analysis and programming capabilities in five areas: Operational Systems, Commercial Applications, Management Information Systems, Applied Sciences, and Systems Programming. In each of these areas it has demonstrated an unexcelled degree of proficiency, and in many instances it has made major contributions to the advancement of programming technology. ☐ The division also maintains modern computer service centers supported by a large staff of programmers, analysts and operations personnel. These centers are operated on the same basis as a public utility, available to any data processing user. ☐ As a result of its proficiency in computer center operation, Computer Sciences won a long-term contract in 1965 to

Clockwise from bottom:
William R. Hoover, President
Robert G. Dee, Vice President
Vincent R. Grillo, Jr., Vice President, Plans and Programs
George E. Brown, Controller

manage the Atomic Energy Commission's large computation facility at Richland, Washington, and in 1966 was selected by NASA to support the computation laboratory of the Marshall Space Flight Center at Huntsville, Alabama. In the Marshall assignment, the division operates one of the world's largest computer complexes, and conducts research into advanced computer techniques for the U.S. space program. □ The division's staff of systems analysts and programming specialists have a comprehensive knowledge of a wide variety of computing equipment. Despite aggressive competition for personnel in the software field, Computer Sciences has been able to recruit and retain one of the largest professional staffs in the United States, without compromising its acknowledged high professional standards. □ The division's headquarters are in El Segundo, California. *(continued overleaf)*

multi-programming, ready access, and photos from space

Each time the United States launches an unmanned spacecraft to the moon or one of the planets, a highly sophisticated data processing system designed by the Computer Sciences Division is brought into play. The success of such history-making space projects as the photographic missions to the moon and Mars has been materially influenced by this complex system, centered in the Jet Propulsion Laboratory's Space Flight Operations Facility in Pasadena, California.

The effectiveness and versatility of the JPL programming system is perhaps best illustrated by a comparison with the system which it replaced. Typically, raw data from the spacecraft would be recorded on paper tape, converted into punched card form, and fed into the computer. The processed data ultimately would be typed out on a printer as project officials and other space scientists waited anxiously for it.

The difficulty with this system was that it could not furnish processed data rapidly enough; nor did it allow space scientists to look at raw data quickly enough to enable them to send corrective commands to the spacecraft. In addition, this system was subject to error since there were steps involving human handling of the data. JPL and NASA sought a system which would eliminate any human data handling and which would respond more readily to the needs of the many persons involved in each space probe. Consequently, JPL called on Computer Sciences to design and implement such a system.

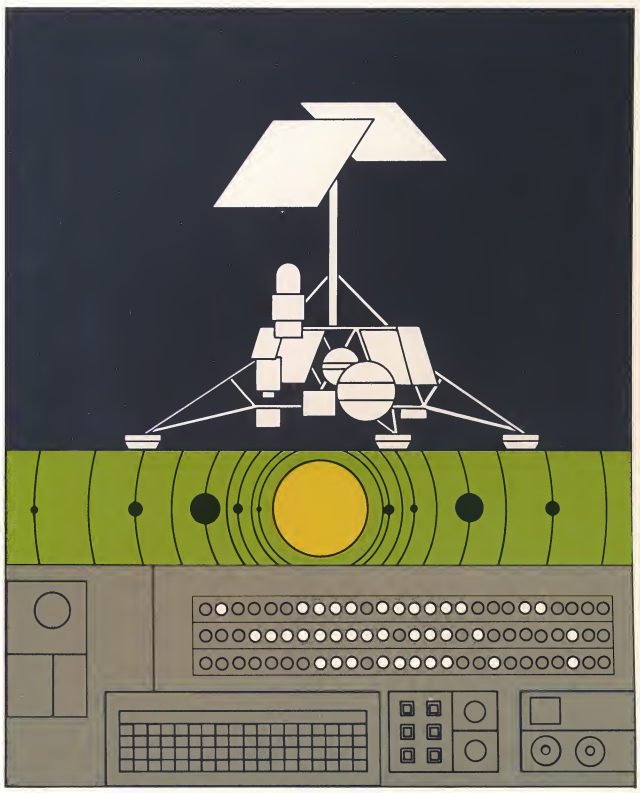
The task was one of the most challenging Computer Sciences ever faced, for two reasons: The functions JPL wanted the new system to perform required a more complex design than anyone had ever executed before, and an unusually large amount of equipment was to be included to perform all of the system's assigned duties.

Computer Sciences first assisted JPL in selecting the peripheral equipment to be used with the two IBM 7094 computers which were to be the heart of the new system. Computer Sciences systems analysts also consulted with the space scientists and spacecraft engineers who were to work with the new system, and drew up specifications for the total system. They then proceeded to develop the intricate programming for the system.

The outstanding features of the new system are its ability to perform a number of tasks simultaneously and the ready access afforded the many users of the system.

At any given moment the system may be receiving and recording data from several spacecraft tracking stations, sending data to a number of other stations, and all the while be performing extensive computations on previously gathered data. This simultaneous activity is made possible through the pioneering application of a technique now known as multi-programming, in which a number of programs are operating virtually at the same time.

The multi-programming capability is made possible through the use of a priority control program which controls the programs performing the various functions of the mission. The priority control program constantly monitors the status of the system, maintains a list of the tasks which need to be performed, and transfers control of the computer to the appropriate program at the right moment. It is generally recognized in the data processing industry that in developing this capability for the Space Flight Operations Facility, Computer Sciences substantially



advanced the state of the art in computer programming.

Access to the system has been provided to space scientists and spacecraft engineers through the inclusion of what are called "user areas." A typical user area contains high-speed printers, plotting devices, a punched card reader, and a keyboard for feeding messages and requests directly into the computer. Thus, users of the system no longer must wait until data is processed and printed out; they can ask for and get raw data as it is being transmitted by the spacecraft, and they can transmit commands back to the spacecraft immediately.

The new system went into operation in 1964, and since has been used in conjunction with a number of unmanned space probes. It has proved highly successful, and in at least one instance has been used to control and process scientific data from two major spacecraft simultaneously.

Other offices and professional staffs are strategically located in Washington, D.C.; Houston, Texas; San Francisco and San Diego, California; Richland, Washington; and Huntsville, Alabama. ☐ In the following paragraphs the division's services are spelled out in greater detail and specific applications of its capabilities are described. ☐ **Operational Systems.** Computers are being used increasingly in military and space systems to provide processed data in real time — that is, virtually as fast as events occur. Computer Sciences has designed the programming systems for a number of operational systems, participating in the development from operational analysis and system design through final checkout and operational support. ☐ Experience of the division's professional staff in this area ranges from an air defense system in which computers perform such critical tasks as calculating guidance

equations for interceptor aircraft, to a spacecraft control system which makes computations for corrective maneuvers within seconds after such action is indicated. The spacecraft control system, installed at the Jet Propulsion Laboratory's Space Flight Operations Facility, played a central role in the historic photographic explorations of the moon and Mars. ☐ Computer Sciences is prepared to provide on-the-job training for both the management and technical implementation of operational systems, and is capable of providing classroom instruction for customer personnel during the transition of responsibility from Computer Sciences to the customer. ☐ **Commercial Applications.** Computer Sciences has applied modern computing equipment and techniques to problems in nearly every major industry. ☐ The division offers a complete range of services to business *(continued overleaf)*

keeping track of oil in 4,000 tanks, and computing royalties

A large, rapidly growing oil company found that its system for inventory control and production reporting was becoming increasingly cumbersome. These functions were being performed by clerical personnel and small-scale data processing equipment, but as the company expanded, the existing system was unable to keep up with the demands on it. At the same time, the system was growing more and more expensive to operate.

The company saw that if it was to continue its growth, it would have to improve its procedures for the development of inventory and production information. Management consequently decided to install a massive, all-encompassing data processing system with a twofold objective: to provide a faster, more complete flow of information, and do so at a substantial reduction in cost.

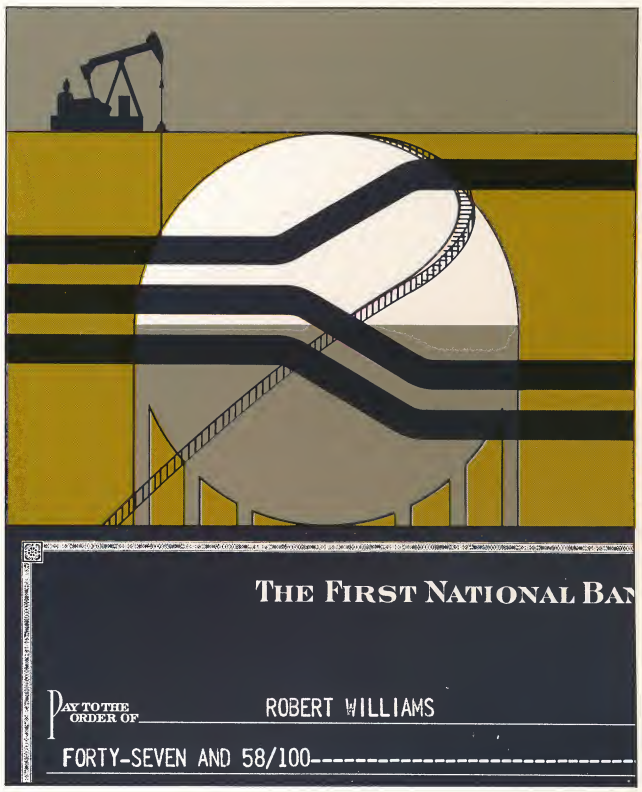
The oil company's data processing staff established the tasks the new system was to perform. But because of the magnitude and complexity of the proposed system, management decided it needed the counsel and assistance of specialists before proceeding further. The company consequently chose Computer Sciences to implement the proposed system.

The division's systems analysts soon determined that the proposed system would require far more extensive and versatile programming than could be accommodated by the computers the oil company had planned to use. These machines would have required two hundred hours a month to generate the required reports and other documents—far too long to meet deadlines over which the oil company had no control. For example, royalty payments had to be computed and then made out by the computer within less than one hundred hours after receipt of production data each month.

Computer Sciences found that to accomplish the assigned tasks in the available time, the oil company would need the use of one of the largest, most powerful computers in existence. But installing such equipment would mean forfeiting much of the savings anticipated from the new system, since the high-capacity computers cost more than $3,000,000 to purchase and $75,000 or more on a monthly lease. Computer Sciences solved the problem by arranging for the oil company to use the extremely fast, large-memory computer at the division's service bureau in El Segundo, California, on a part-time basis. The more powerful computer, it was found, could produce all of the desired reports in only twenty hours—one-tenth of the time which would have been required with the smaller equipment originally planned for the system. And the oil company had to pay only for the time it used the large computer.

Computer Sciences then went on to redesign the data processing system for the larger computer, adding a number of additional capabilities to make full use of the equipment's greater capacity.

The result is the largest inventory and production reporting system ever developed for the petroleum industry. It will consist of approximately three hundred files, or sets of data, which will be utilized by eighty separate programs and can be sorted, or arranged, in two hundred different ways. The inventory reporting phase of the system alone contains programs which will assemble and process information on the status of the oil company's vast stocks of crude oil in some 4,000 tanks—the origin



of the oil, the amount on hand at each location, and the details of approximately 10,000 movements of crude oil each month.

When it is fully operative, the system will produce a total of two hundred separate reports for corporate and division management and for federal, state, county and municipal government agencies. In addition, it will compute royalties and make out checks to approximately 15,000 oil leaseholders. Moreover, it will improve operating efficiency in a number of areas; for example, it will compare current well production rates with previous performance records to locate wells which are producing less and need reworking, thus freeing field personnel for more productive activity. Most important of all, it will perform these tasks at a saving of more than $100,000 a year over the system previously utilized by the company.

and commercial organizations, including management sciences consultation, conversion of manual and tabulating systems to computer systems, and the design and implementation of complete data processing systems. □ A partial listing of the specific applications developed by Computer Sciences provides an idea of the division's experience and versatility. For financial institutions, the division has designed systems for stockholder records maintenance and loan accounting and analysis. For manufacturers, there are systems for inventory management, production control, procurement, product engineering and other functions. And for business and industry in general, the division has developed special purpose systems for a number of areas, including personnel information, sales analysis and reporting, general ledger accounting, payroll and labor distribution, accounts payable and receivable,

and library indexing. □ **Management Information Systems.** The computer has become increasingly valuable to management as an aid in decision-making when employed as part of a comprehensive, properly-designed management information system. The professional staff of the Computer Sciences division includes nationally-known specialists in this new field of management information technology. These senior specialists are highly skilled in the development of systems which 1) retrieve and present to management the significant information in data being processed and 2) enable management to inquire directly into information pools without going through intermediaries. The division's extensive experience in operational systems makes it particularly qualified to design management information systems which operate in real time, recording, analyzing and *(continued overleaf)*

enabling a computer to serve hundreds of users simultaneously

The most significant development in expanding the usefulness of the computer has been to make it possible for the machine to simultaneously serve a large number of users at distant locations. This is called time-sharing.

Remote consoles linked to the computer by telephone circuits enable users ranging from scientist to schoolboy to transmit their problems to the machine and receive their solutions almost instantaneously. The computer works on many problems at once, but its speed is so great it appears to the user that his is the only problem being processed.

The Computer Sciences Division made a major contribution to the development of the intricate programming system necessary for such a machine. The manufacturer of this new computer required that it accommodate several hundred consoles, and specified that each user be able to draw on the full range of the computer's services at any time, without interference from other users. Moreover, data stored in the computer's central memory had to be immediately available for use; yet the system had to prevent unauthorized use of the stored data and safeguard all data from accidental alteration or erasure.

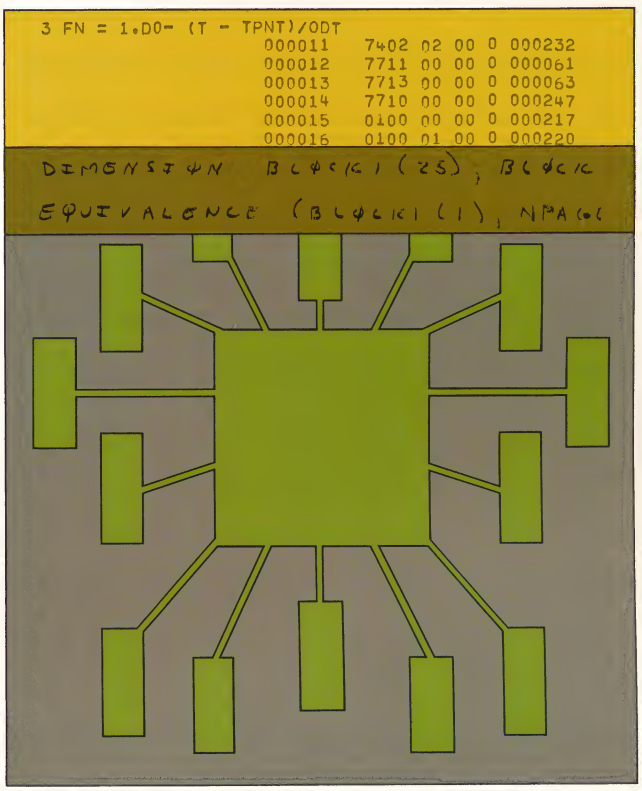
Computer Sciences was brought into the project initially as a consultant to assist in developing the overall design of this new system. In this assignment, the division contributed many of the conceptual ideas on which the programming system would be based.

As a result of the proficiency Computer Sciences demonstrated as a consultant in the early phases of the project, it not only was retained in this capacity throughout the development of the system, but was also assigned the responsibility for the detailed design and final implementation of major segments of the system. This task involved the development of solutions to a number of problems stemming from the complexity and highly advanced nature of the time-sharing system.

For example, Computer Sciences had to develop new and modified techniques to enable the computer's compilers to operate in a conversational mode — a system enabling man and computer to "talk" to each other about a problem while it is being processed, rather than having to await its completion. For instance, a mathematician can see the effects of inserting new data to vary equations in his problem during the computation process. Through the conversational mode the machine also notifies the user by printed message when an erroneous statement occurs in a program, or when additional data is necessary to complete a computation. Another advantage is that this type of system makes it easier for users to check out their programs from remote consoles.

Since a major new programming language was to be used with the system, a complete analysis of its syntax was required, and new design and optimization techniques had to be developed to enable effective implementation of the language.

Still another problem encountered was the requirement for a system which could instantly locate any of the thousands of program segments stored by users in the computer's memory. The problem was acute because the new system was to accommodate more users than any earlier computer; it was further magnified because new methods of filing programs and data in the memory had been developed for this equipment. Computer



Sciences helped design a new, highly flexible file handling method that enables the user to obtain his program from storage from his remote site, modify it, perform computations on it, and control routing of the output data. In addition, each user may share his working programs and data files with other users, or he may specify that he alone have access to them.

Computer Sciences thus participated extensively in every phase of this major software development program, from formulation of the system concept through design, program coding and implementation. The result was a product that not only met all of the manufacturer's specifications but in many cases exceeded them. Moreover, Computer Sciences once again demonstrated its ability to complete an extremely demanding assignment within the confines of a stringent development schedule.

presenting data to management as soon as an event occurs. ☐ Unlike many organizations, Computer Sciences offers a start-to-finish capability in this field, from the identification of key factors in a client's decision-making process through the development of a system concept and installation of the operational system. ☐ Computer Sciences' achievements in this area include the development of a complex management control system for aircraft production and an extremely comprehensive production and inventory reporting system for a large oil company. ☐ **Applied Sciences.** Computer Sciences has served numerous scientific and engineering organizations by restating complex problems in a form intelligible to the computer. The division performs this function with a staff of specialists who are equally as knowledgeable in applied mathematics and numerical analysis as they are in computer programming techniques. ☐ The Applied Sciences staff is capable not only of designing complete scientific data systems which use specifications provided by clients; in many instances, it performs the even more demanding task of developing original mathematical models for solving problems in areas such as structural analysis and astrodynamics. In addition, after a system has been implemented, Computer Sciences will provide for its

maintenance, operation and support, should the client desire. ☐ Computer Sciences has performed these services in a number of U.S. space and military programs and in other scientific projects as well. ☐ **Systems Programming.** Computer Sciences has produced more operational programming systems than any other software company, and it has developed major programming systems for all leading manufacturers of computing equipment. ☐ This type of programming provides the solution to two perennial data processing problems: how to bridge the communications gap between the computer and the computer user, and how to avoid wasting the computer's valuable processing time during operation of the slower equipment which transmits information to and from the computer itself. ☐ In several software development projects, Computer Sciences has significantly advanced the state of the art in the computing industry. Its compilers, for example, are universally acclaimed for their tightness of design, speed and efficiency of resultant computer coding. The division also has applied the new technique of time-sharing to several newer computers. ☐ In addition, the division has been called on by several leading manufacturers to assist in developing the concept and basic design of new computer equipment.

Communication Systems Division

☐ The Communication Systems Division provides a broad range of engineering services for the design, development and implementation of large-scale communications and information systems. Since its formation in 1959, the division has planned, engineered, tested and evaluated some of the largest, most advanced communications systems in the world. ☐ Communication Systems was founded by a major communications-electronics company to provide systems engineering for a U.S. Air Force global communications network designated the 480-L System. When the Defense Communications Agency was formed, Communication Systems undertook a number of projects for that organization, and subsequently performed services for the U.S. Army and the Federal Aviation Agency. ☐ The opportunity for Computer Sciences to acquire this organization arose when the former parent company decided to divest itself of Communication Systems to obtain release from government conflict-of-interest restrictions. The division has since accelerated its customer diversification program, and now serves industry, commerce and a wide range of government agencies. ☐ The role of Communication Systems is comparable to that of an architect. In a typical project, members of the technical staff first analyze a client's general

Clockwise from bottom:
Armig G. Kandoian, President
William Sichak, Vice President and Technical Director
Frank J. Cerne, Controller
Ralph B. Reade, Director, Plans and Programs

plan for a new system or a modification of an existing system and make recommendations for improving its effectiveness. They then design and engineer the system to the point at which an equipment manufacturer can determine the detailed specifications for the system and produce it. Communication Systems itself does not manufacture any equipment, enabling it to remain completely objective in its design role. ☐ The technical staff of Communication Systems consists of more than two hundred and fifty multi-disciplined engineers and scientists with an average of fifteen years' experience in communications and electronics. The division has its headquarters and principal facility in Paramus, New Jersey; there it maintains a specially equipped laboratory to support its projects and its research and development activities. Other major facilities, each with its own technical

staff, are located in the Boston suburb of Waltham, Massachusetts, and in Falls Church, Virginia, just outside Washington, D.C. Field and technical liaison offices are maintained in Wiesbaden and Heidelberg, Germany. ☐ Communication Systems' capabilities fall into four broad areas: Operational Analysis, Systems Concept and Design, Systems Integration and Implementation, and Management Information Systems and Methods. These capabilities are summarized in the following paragraphs. ☐ **Operational Analysis.** This new technology is used to lay the groundwork for the design and implementation of new information-communication systems. It involves identifying and describing in detail the interaction of all elements of an organization or process, utilizing the latest techniques in mathematics, econometrics and electronic computation. These descriptions, *(continued overleaf)*

developing a system to double the output of air weather data

Less than a year after it began operation in 1961, the U.S. Air Force's new worldwide weather reporting service was being severely taxed. Aircraft were flying faster, higher, farther and more often than ever before, and were requiring weather information with increasingly greater frequency and detail. Moreover, the weather service was further burdened as a result of several international incidents, such as the Cuban crisis, which occurred in 1962.

Seeking to alleviate the problem and provide for future requirements, the Air Force came to the Communication Systems division with a twofold assignment: Determine the requirements for aeronautical weather data in the 1965-70 period, and develop a plan to accelerate the flow of data from source to user. To achieve these objectives, Communication Systems organized a complete systems analysis group comprising requirements analysts, systems engineers and data technicians.

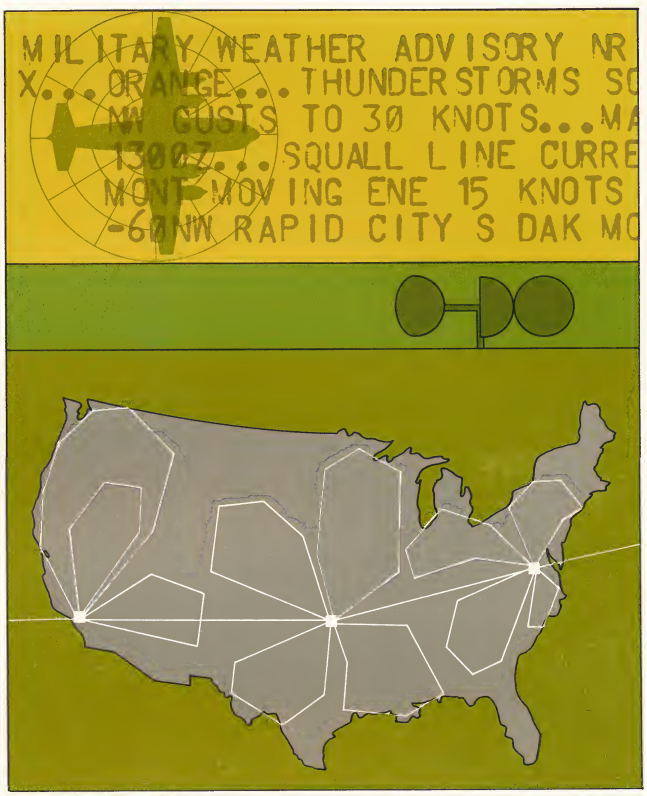
At that time there were approximately 10,000 sources of aeronautical weather data throughout the world, from fully staffed major installations to individual observers at remote locations. Communication Systems polled these sources, either by personal interviews or by mail, to determine the type of data the source was planning to generate with the new sensory equipment which would soon be installed. The division's engineers then went to the 850 military user groups which would receive this information to determine what their requirements would be under forthcoming new operational plans; these requirements were compared with the plans of the source stations and the discrepancies resolved.

The massive amount of data gathered up to this point was then broken down to show each step in the transmission of data from source to ultimate user. This analysis showed there would be 295,000 separate reports daily. Each was noted on a punched card, and the data was analyzed by computer to determine the pattern of the reports by source, user and bulletin type.

Through such extensive research, Communication Systems was able to demonstrate to the Air Force that its weather information requirements would increase to at least 4,500,000 words daily in 1970, more than double the 2,000,000 needed in 1962. The division then proceeded to the problem of developing a system which would be capable of processing this vastly expanded volume of information smoothly and rapidly.

From the 295,000 punched cards indicating each message to be required, Communication Systems analysts were able to determine size requirements for trunk lines. For example, it was indicated that there would be approximately 5,000 messages a day between New York City and the key British weather station at Croughton, England; by finding the busiest hour and minute of each day, and learning from interviews the maximum allowable delay in each message, the number of transatlantic circuits which would be needed in the 1965-70 period was determined.

In its study of the existing weather reporting networks, Communication Systems had found that most of the information sent over each circuit was being used by only a few of the receiving stations. Specifically, two-thirds of the many stations on each circuit wanted less than half of the total volume of information transmitted. As a result, aeronautical weather editors, who are perennially in short



supply, were spending much of their time separating the usable from the unwanted data, and costly teletype circuit time was also being wasted.

Communication Systems proposed streamlining this system by dividing the continental U.S. into three sections and equipping each with a computer-based central switching center which would serve a larger number of small loops with only the information they required. Five overseas areas would be similarly organized and equipped, and connected to the continental U.S. network.

The proposed system subsequently was approved, and construction of the first computer-based switching center was begun at Tinker Air Force Base in Oklahoma. When the complete system is in operation, it will provide markedly faster service, sharply reduce editing time, and eliminate approximately 20,000 miles of teletype circuits.

in turn, provide the basis for developing a concept of an information-communication system, and for determining its organization and geographic configuration. Communication Systems has applied its operational analysis techniques in a wide variety of situations, from complex military systems for command, warning and intelligence, to weather forecasting and civilian aircraft traffic control systems. □ **Systems Concept and Design.** Communication Systems is an unusual engineering organization in that it is able to provide both the concept and the design of a system. In most instances, a system is conceived by members of the customer's own staff, who naturally are concerned principally with its performance; it is usually designed by the staff of the manufacturer, who of course wants to produce it as economically as possible. In performing both of these *(continued overleaf)*

redesigning a major communications net to include automation

Early in 1966 the U.S. Air Force's Electronic Systems Division, acting for the Defense Communications Agency, called on the Communication Systems Division to pave the way for a major revamping of U.S. military communications facilities in northern Europe.

The basic requirement was to plan and engineer the modernization of seventy-five radio stations to achieve heightened efficiency of the existing system and to make it capable of supporting the transmission requirements of new computer-based automatic switching systems for voice and digital traffic.

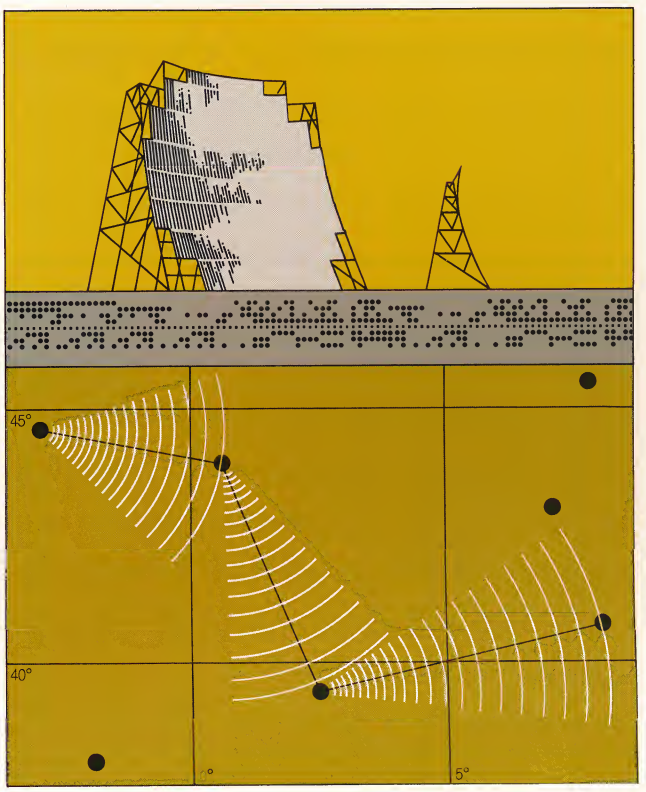
The task would have been a complicated one under normal conditions. It was made more difficult because of special considerations which required that the entire design be completed in half the time usually allotted such a project. Because of this urgency, Communication Systems undertook the first two phases of the program concurrently: the preparation of a preliminary design for the modernized system, and a survey of the actual facilities to determine precisely what improvements could and should be made at each station.

Communication Systems had an excellent data base to start this project. Under previous government contracts it had surveyed the majority of the military communications installations around the world. However, many installations had since been modified, some extensively; others were being altered by the local military agncies and commands which operated them. To ascertain what changes had been made, were in process or had already been planned and funded at the local level, it was necessary to visit each of the seventy-five stations.

As the new designs were completed at the division's U.S. headquarters in Paramus, New Jersey, they were sent to the survey teams in Europe. These teams spent up to four days at each installation, carefully examining every facet of the facility and comparing it with the preliminary design. The survey included not only the communications equipment, but other aspects such as the antennas and towers, the buildings housing the equipment, the roads leading to the installations, and logistic support. The preliminary design might, for example, have called for the utilization of space which the earlier surveys showed vacant, but which had since been utilized; it was the responsibility of the survey teams to note such changes and to suggest alternate solutions.

When the preliminary design of the new system was completed and all stations had been surveyed, Communication Systems engineers at the division's U.S. headquarters were able to compare their design with the survey results, make the necessary changes and complete detailed design of individual stations. Ten weeks after it was given the assignment, Communication Systems presented its evaluation of the existing system and its first draft of the new system to the Air Force.

After careful study, the Air Force ordered a number of changes in the design to reflect changing requirements and to provide additional special-purpose capability. It then became Communication Systems' task again to ascertain whether these changes were feasible without making major revisions at the various installations concerned. Because the survey teams had brought back such extensive and detailed information on each of the sites, the division's engineers were able to incorporate



the changes into the final design without having to revisit any of the facilities involved.

The magnitude of the assignment is evidenced by the fact that at one time there were 106 Communication Systems and subcontractor personnel working on this program, and that the final reports consisted of five volumes and sixty-eight supplementary sections—approximately 2,500 pages of text and illustrations in all.

Within three months after it was called in, Communication Systems submitted its final reports to the Air Force. The reports incorporated an overall design and recommendations for the modifications required to implement it. In addition, they provided complete statements of work for the overall system and for each component site which the Air Force could give to appropriate government agencies and to contractors for implementation.

tasks, Communication Systems assures the customer that the best combination of cost and effectiveness is achieved. ☐ The division applies this dual capability to existing systems as well as to new projects, testing the operational concepts of such systems and redesigning them to suit new purposes and incorporate the latest technological advances. Designs and recommendations of Communication Systems have been implemented by the U.S. Armed Forces throughout the world, and concepts for military and civilian systems of the next decade have been submitted to the Defense Department and to civil agencies of the Federal Government for evaluation. ☐ **Systems Integration and Implementation.** Once a system has been designed and a manufacturer has been selected to produce it, the customer faces a new set of problems. The project must be supervised to insure that the design is followed accurately, that the equipment is installed properly, and that the implemented system fully meets the requirements established for it. The staff of Communication Systems includes a group of engineers specializing in the integration and implementation of complex communications systems. The experience gained by these specialists in a wide variety of projects enables them to quickly pinpoint substandard or unacceptable

performance and to make effective recommendations for corrective action. These experts also are experienced in developing standards for evaluating a system's performance, and thus can insure that acceptance tests prepared by the manufacturer constitute a truly thorough test of the system. □ **Management Information Systems and Methods.** The division's extensive experience in the design and implementation of large-scale systems for conveying information has provided a base for the development of a strong capability in management information systems. The need and demand for such systems has become increasingly strong recently as a result of two factors. First, electronic data processing equipment has complicated the decision-making process by presenting considerably more information than most managers have time to comprehend. And second, the U.S. Armed Forces are requiring contractors to maintain an ever greater degree of cost control over each phase in a project's development. The technical staff of Communication Systems, with an intimate knowledge of the problems and processes of the communications-electronics industry, is well qualified to determine the kinds and amounts of information required at each level of management and to design effective systems to provide this information.

System Sciences Division

☐ The System Sciences Division of the company was formed in 1962 to provide both engineering and management support to the U.S. Defense Communications Agency in the development of the Defense Communications Satellite System. While continuing to provide its services in this long-range program, System Sciences has expanded its range of capability well beyond its original scope. Today the division applies scientific, engineering and management disciplines to develop solutions to a wide variety of problems associated with advanced technological projects and programs. ☐ Computer Sciences was able to acquire System Sciences because the division's original parent, an international communications-electronics corporation, sought release from government conflict-of-interest restrictions and decided on divestiture as the solution. System Sciences subsequently embarked on a major diversification program, making its services available to other organizations; as a result, the division since has received assignments from the Army, Navy, Air Force and the National Aeronautics and Space Administration, and also has served the private sector of the communications industry. ☐ System Sciences is headquartered in Falls Church, Virginia, just outside Washington, D.C., and near almost all

Clockwise from bottom:
Alvin E. Nashman, President
Richard M. Hultberg, Vice President and Director of Operations
Leonard J. Rennenkampf, Director, Senior Scientific Staff
George L. Neaderhouser, Treasurer and Comptroller

major government agencies. The division has access to the extensive computer facilities at a Navy installation in nearby Dahlgren, Virginia, as well as those of the Computer Sciences Division. System Sciences has field offices at Fort Monmouth, New Jersey, and El Segundo, California. □ The division's technical staff has an average of more than thirteen years' experience in a wide range of fields, including engineering, mathematics, economics, operations research, computer simulation and programming, and management sciences. More than half of the staff have advanced degrees. □ System Sciences provides two types of services: 1) systems engineering and management assistance for aerospace and communications programs, and 2) study and analysis of specific technical problems. These services are described in the following pages. *(continued overleaf)*

project coordination, geos A, and better 3-D maps of the earth

The System Sciences Division contributed extensively to the success of Geos A, one of the most productive unmanned U.S. satellites. Geos, also known as Explorer XXIX, was designed to provide scientists with data to establish a more accurate model of the earth's gravitational field and map the earth's surface in a precise three-dimensional reference system.

System Sciences performed three functions in the Geos A program: 1) It supervised integration of the total program, 2) it designed a major system element, and 3) it provided solutions to critical operational problems.

Initially, System Sciences was called on to support the NASA project manager in the deployment of the satellite and in the operation of the ground stations involved. This required coordinating every phase of the program, from assembly and checkout of the satellite to the plans for utilizing data provided by it.

When problems arose, System Sciences acted to insure that corrective action was taken. For example, mechanical difficulties developed in mating the satellite with the new, more powerful third stage rocket to be used for the first time in the Geos A launching. System Sciences engineers worked closely with the agencies and contractors concerned to solve these difficulties.

System Sciences broadened its role in the program when NASA asked it to support the development of the Geodetic Operational Control Center. This unit coordinates the activities of the satellite tracking network, satellite command stations, geodetic ground stations, geodetic data service, and the computer system for scheduling ground observations of the satellite. System Sciences designed and built the center's data display systems, wrote and checked out its operating procedures, planned and helped to conduct readiness tests, and assisted in training the center's personnel.

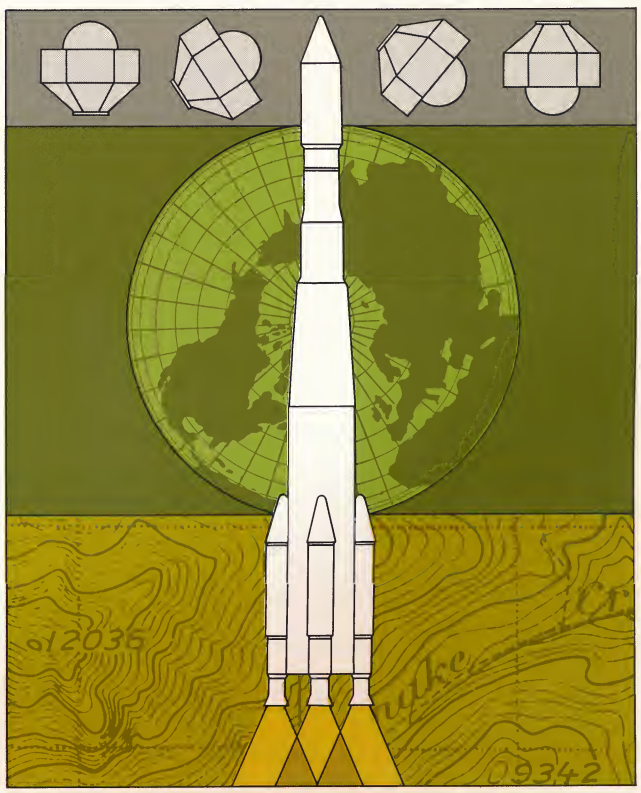
Finally, System Sciences was instrumental in achieving effective operation of Geos A, providing a plan for corrective action when trouble developed after launch.

The design of the satellite required that it be stabilized in orbit with its operational face always pointing toward the earth. Stabilization was to be achieved with a telescoping fifty-foot boom which would be aligned by the earth's gravitational field; once the spacecraft was in orbit and tumbling, the boom was to extend and lock Geos A into a permanently upright position.

But the project's success was jeopardized by a quirk of chance. Before it could tumble into the proper position for the boom to be extended, the satellite assumed a semi-stable attitude in which its solar cells were pointing away from the sun. Immediate corrective action was required before the spacecraft starved for power and failed to respond to any ground commands.

Consequently, the boom was commanded to extend, even though the satellite was not in the proper position for this maneuver; as a result, it stabilized in an inverted position in relation to earth, but the move had the beneficial effect of exposing some of the spacecraft's solar cells to the sun. The next step, after the Geos A had absorbed sufficient energy, was to withdraw the boom, allow the satellite to tumble into an upright position, then lock it into position by extending the boom once again.

The success of these maneuvers depended on precise timing of the commands to the spacecraft; thus it was



essential that the proper selection of transmitting stations be made.

System Sciences determined that the best combination of stations was a NASA facility and a station in the Navy's satellite tracking network. This, however, posed a formidable problem in coordination, since the operating procedures of the two networks differed markedly. But System Sciences went on to determine the timing for the maneuver, write common procedures for the two stations, and coordinate the efforts of both. The maneuver was successfully executed, and Geos A has since provided a large volume of useful information.

NASA subsequently chose System Sciences to coordinate the follow-up Geos B program and, afterward, to conduct further studies in geodetic satellites and recommend techniques for improving such spacecraft.

☐ **Systems Engineering.** When a client calls on System Sciences to act as a systems engineer, the division not only coordinates and integrates a program but also is able to provide specialized technical skills when the need arises. Generally, systems engineering involves four functions: 1) intensive analysis of system requirements; 2) searching comparisons of numerous technological approaches to determine the optimum combinations of personnel, performance and costs; 3) the making of key decisions based on these comparisons; and, 4) the efficient integration of personnel, material, and methods of operation to produce the best possible total system to accomplish a given task or mission. ☐ System Sciences has performed systems engineering for several large projects, including the Defense Communications Agency's worldwide satellite program and NASA's geodetic satellite program. ☐ **Special Studies and Analyses.** In space programs and other large programs involving new technologies, technical problems arise during nearly every phase of development. Such problems may be no more than the normal difficulties to be expected in new technological areas, or they may be critical, unforeseen problems which have occurred as a result of some malfunction or deviation from a planned order. Still

other situations arise which require an investigation into the feasibility of a proposed new system through the use of computers and other devices to simulate the system. □ System Sciences has made valuable contributions to space technology and other fields through such studies. In conjunction with its activities in satellite communication, for example, the division made probing studies to determine the best method to enable a satellite to handle more than one transmission at a time. These studies resulted in the development of significant new proprietary information, and the division has patents pending on the processes involved. □ System Sciences complemented and further expanded its capabilities early in 1966 with the acquisition of Geonautics, Incorporated. Geonautics is highly skilled in the fields of geodesy, navigation, astronomy, oceanography and hydrography, and has applied these capabilities in a number of space programs and other projects involving investigation of the earth's environment. In one project, Geonautics determined the precise alignment and orientation required for Telstar and other communications antennas throughout the world; in another, it designed a backup pilotage navigation system and associated devices for the forthcoming Apollo lunar exploration voyage.

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Alfred Polit

Politz Research Division

☐ The Politz Research Division is a recognized leader in the large and increasingly important field of marketing research. Since its formation more than two decades ago, Politz has helped a wide variety of clients to solve marketing problems and achieve substantial improvement in their competitive positions. ☐ Politz has served manufacturers of consumer goods and industrial products with equal effectiveness. The division makes recommendations for the introduction of new products and advises clients on marketing methods and advertising concepts. ☐ To develop its recommendations, Politz conducts extensive field surveys to establish causes and effects of consumer behavior and reveal the shifting patterns of demand in consumer and industrial markets. ☐ Politz has pioneered many significant advances in the field of marketing research. It was the first organization to apply the mathematical techniques of probability sampling to commercial market research. Today this method of scientifically designating persons to be interviewed in surveys is generally used by most research firms. ☐ In another innovation, Politz itself entered the retailing business to provide staff members with an opportunity to obtain experience in marketing and to test new marketing strategies. ☐ Augmenting the Politz Division's capa-

Left to right:
A. Edward Miller, President
Leonard N. Daniels, Controller
Alfred Politz, Chairman

bilities is a separate but closely affiliated organization, Universal Marketing Research. In addition to its general marketing research function, UMR provides a number of special services, such as the collection and analysis of trend data and other information on a low-cost basis. □ Headquartered in New York City, Politz has approximately 150 employees, a large proportion of whom have professional training in the behavioral sciences, statistics, economics, sociology and marketing. The division is able to call on a field staff of more than 800 experienced interviewers, a number of whom work exclusively for Politz. □ Politz's areas of capability are described in more detail in the following paragraphs. □ **Marketing Research.** Politz's principal objective is to provide information which will enable a client to improve his product and marketing program in general and his advertising

efficiency in particular. □ Before undertaking a consumer survey, Politz analysts intensively study the client's business and industry. This provides general background and helps to identify areas in which marketing research can be most effective. □ Next come searching interviews with up to one hundred users of the type of product made by the client. These interviews form the basis for a questionnaire to be used in a full-scale survey. □ Probability sampling yields a group of interview subjects who are statistically representative of the total population under study. By mathematical formula, Politz designates each address to be visited throughout the nation and specifies who in the household is to be interviewed. □ Politz researchers then conduct the major survey. Depending on the nature of the problem, this may involve only a regional market or *(continued overleaf)*

improving the quality of a slipping product, and increasing sales

A major tobacco company came to Politz not long ago with a critical problem: Sales of its leading filter cigarette, once quite popular, had slipped sharply in the face of competition from new brands. The tobacco company thought the trouble lay in its advertising, and asked Politz to make a national survey to ascertain what smokers thought of the cigarette and how they reacted to the advertisements for it.

Politz developed a questionnaire with nearly one hundred questions designed to elicit responses which would provide insight into the cause of the problem, and distributed them to its interviewers throughout the United States. For several months, Politz representatives interviewed smokers in their homes until some 8,000 had been questioned at length about their smoking habits.

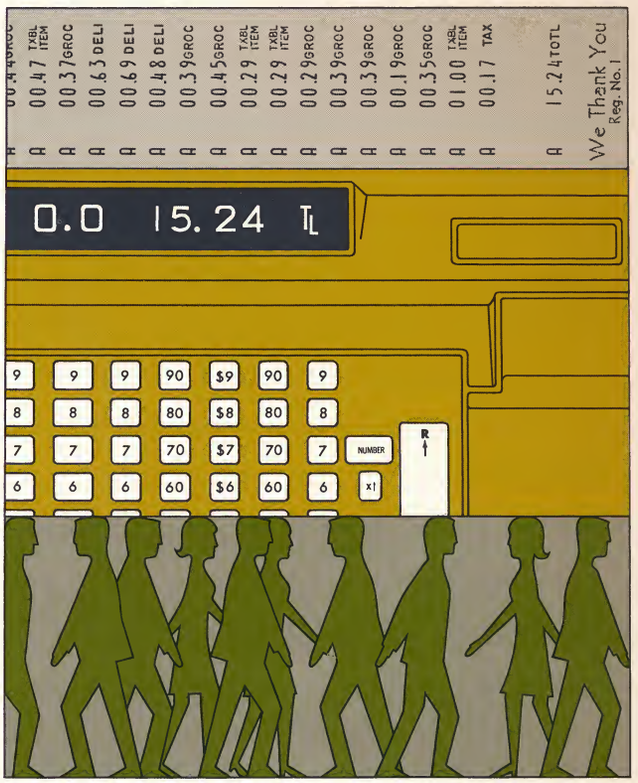
Even before the survey was completed, Politz was able to advise the tobacco company on the basis of preliminary findings that the cigarette itself, as well as the advertising, was deficient. Smokers who had tried the cigarette found it wanting in one or more respects, and even those who had never smoked it felt it was less desirable than competing brands. What had happened, Politz determined, was that the client had failed to improve his product during a period in which competitors had introduced new brands and altered existing brands to satisfy the public's changing tastes.

The Politz research thus made it apparent that both the cigarette and the advertising would have to be revised. On Politz's recommendation, the tobacco company's chemists developed about twenty experimental cigarettes, each with a different combination of tobacco blend, tobacco stem content, and flavoring. (Artificial flavoring is a key ingredient of all cigarettes.)

Politz then tested the cigarettes by distributing them to smokers of filter, non-menthol brands, including the client's brand. Five packages of one experimental blend were given to each smoker in groups of 150 to 400; some twenty groups were involved, since no group was given more than one experimental blend. At the same time, each smoker was given five packages of his own brand and was asked to compare the experimental blend with his regular cigarette.

Each smoker was asked a number of questions, but the key queries were simply how much he liked the brand, how it compared with his own brand, and whether he would switch to the unmarked brand if it were on the market. Of the twenty experimental blends, half a dozen were found which smokers considered far superior to the company's existing cigarette and which also compared very well with those of leading competitors. The tobacco company selected from these the blend which had the optimum ratio of smoker's preference to manufacturing costs. This blend was adopted as standard and the existing blend discarded.

Concurrently, Politz was conducting other tests to insure that the new advertising developed by the client would be effective. The newly created television commercials, which were to constitute the bulk of the advertising, were linked with films of unrelated subjects such as the exploits of U.S. astronauts; these films were shown to smokers at their homes and in mobile theater units parked at shopping centers. After each viewing, the smoker was questioned briefly about the body of the



film, then was asked his opinion of the cigarette — not the advertising, but the product itself.

At the same time, Politz interviewers were showing a second group of smokers the same basic film strips. These films, however, did not include the client's advertisements. The second group of smokers — similar in age, occupation, education and other demographic characteristics — was then asked the same questions as the first group. By comparing the intensity of the responses of the two groups, Politz was able to predict which of the new advertisements would be most effective.

Thus Politz performed two valuable services for the tobacco company. It provided the research basis for the development of a vastly improved product, and it pretested the client's new advertising. As a result of these efforts, the client's sales subsequently rose fifty per cent.

Politz Research Division

require as many as 15,000 interviews nationwide. ☐ Similar techniques are employed in projects for industrial clients. Politz researchers visit companies which are potential customers for a client's product and talk with a number of persons who would be concerned with the purchase and use of the product. ☐ In an extension of its survey and analysis services, Politz has developed an original and highly effective system for testing advertising before it is placed in media. Politz researchers display proposed advertisements to consumers as part of a larger context, such as a magazine or television show, then ask questions about the total presentation, including only a few questions about the advertising itself. The questions concerning the advertising are framed to determine what the consumer thinks of the product itself, rather than the ad. ☐ The same material—without the advertising—is shown to another group of consumers with similar occupations, education, income and other demographic characteristics; the same questions are then asked of the second group. The effectiveness of the advertising is consequently determined by comparing the attitudes of the two groups toward the client's product. ☐ **Media Studies.** The Politz Division uses its large field staff to make detailed studies of the advertising

effectiveness of media. It has measured audiences of television and radio, readership of magazines and outdoor advertising, and exposure to public transit advertising. ☐ Politz performs custom-tailored media studies to meet a client's specific needs, and conducts industrywide surveys to gather a reservoir of data which it makes available on a service basis. The division originated several of the techniques now widely used in media studies. These establish the readership of a given issue of a publication, and the number of times a specific issue and even a specific page are read. ☐ **Marketing Services.** A recently-introduced Politz service enables manufacturers for the first time to obtain data on changes in consumers' preferences among product brands without having to bear the cost of a custom survey. ☐ Under contract to a group of manufacturers of the same type of product, Politz conducts nationwide surveys to learn consumers' current preferences and their reasons for changing brands. The resulting data provide each survey sponsor a low-cost tool for evaluating his product, and enable him to take knowledgeable action to improve his competitive position. ☐ The Politz Division maintains a continuing research program to develop new services which will assist management in the vital process of decision-making.

Clients of the divisions of Computer Sciences Corporation include: A. C. Spark Plug ☐ Accent International, Division of International Minerals & Chemical Corp. ☐ Advertising Research Foundation, Inc. ☐ Aerojet-General Corp. ☐ AiResearch Manufacturing Co. ☐ Allied Chemical Corp. ☐ American Academy of General Practice ☐ American Bankers Association ☐ American Can Co. ☐ American Chicle Co. ☐ American Cyanamid Co. ☐ American Dairy Association ☐ American Gas Association ☐ American Medical Association ☐ American Pipe & Construction Co. ☐ American Savings and Loan Association ☐ American Tobacco Corp. ☐ Ampex Corp. ☐ Anheuser-Busch, Inc. ☐ Applications Research Corp. ☐ Association of National Advertisers ☐ Astrodata, Inc. ☐ Atomic Energy Commission ☐ Automated Building Components, Inc. ☐ Automated Building Maintenance ☐ Automation Industries ☐ Automobile Manufacturers Association ☐ Aviation Safety Engineering Research ☐ Baltimore News-Post ☐ Bank of America ☐ Batten, Barton, Durstine & Osborn, Inc. ☐ Bechtel Corp. ☐ Beechnut-Life Savers, Inc. ☐ Beckman Instruments, Inc. ☐ Bellcomm, Inc. ☐ Bell Records, Inc. ☐ Benson-Lehner, Inc. ☐ Ben Taub Hospital ☐ Bendix Field Engineering Corp. ☐ Better Books, Inc. ☐ Blue Cross/Blue Shield ☐ Board of Governors, Federal Reserve System ☐ Bonner & Moore Associates ☐ Borden Co. ☐ C F Braun & Co. ☐ Briles Manufacturing, Inc. ☐ Bristol-Myers Co. ☐ Broadcast Measurement Bureau ☐ Brown & Williamson Tobacco Corp. ☐ Brown & Root, Inc. ☐ Buchanan & Co. ☐ Bunker-Ramo Corp. ☐ Bureau of Advertising ☐ Burlington Industries, Inc. ☐ Butler Publications ☐ Butterick Co. ☐ Byrum-Kissinger Publications, Inc. ☐ CBS Television Network ☐ C E M E, Inc. ☐ California Computer Products, Inc. ☐ California Department of Fish & Game ☐ California Register Corp. ☐ California Resistor Corp. ☐ Campbell-Mithun, Inc. ☐ Can Manufacturing Institute, Inc. ☐ Canada Dry Corp. ☐ Carlos-Franco Association, Inc. ☐ Carnation Co. ☐ Carter Products, Inc. ☐ Caryl Richards, Inc. ☐ Chicago's American ☐ Henry I. Christal Co. ☐ Chrysler Corp. ☐ Ciba Pharmaceutical Products, Inc. ☐ Cigar Institute of America, Inc. ☐ Ciné Revista, Inc. ☐ Cinch Graphics ☐ Cities Service Oil Co. ☐ City of Long Beach, California ☐ Coca-Cola Co. ☐ Colgate-Palmolive Co. ☐ College Radio Corp. ☐ Columbia LP Record Club ☐ Committee on Space, AAAS ☐ Compton Advertising, Inc. ☐ Conde-Nast Publications, Inc. ☐ Consumer Behavior, Inc. ☐ Continental Carbon Co. ☐ Control Data Corp. ☐ Corn Products Sales Co. ☐ Coty, Inc. ☐ County of Marin, California ☐ Covington & Burling ☐ Cowles Communications, Inc. ☐ Curtiss-Wright Corp. ☐ Edward Dalton Co., Division of Mead Johnson & Co. ☐ Dancer-Fitzgerald-Sample, Inc. ☐ D'Arcy Advertising Co., Inc. ☐ Data Craft, Inc. ☐ Daystrom, Inc. ☐ Defense Communications Agency ☐ Defense Communications Engineering Office ☐ Defense Supply Service ☐ Reuben H. Donnelley Corp. ☐ Doherty, Clifford, Steers & Shenfield, Inc. ☐ Douglas Aircraft Co. ☐ Dow Chemical Co. ☐ Doyle Dane Bernbach, Inc. ☐ Dun & Bradstreet, Inc. ☐ E. I. du Pont de Nemours & Co. ☐ Eastern Airlines, Inc. ☐ Edgerton, Germeshausen & Grier, Inc. ☐ Educational Services, Inc. ☐ Electronic Communications, Inc. ☐ Electronic Specialty Co. ☐ Ellington & Co., Inc. ☐ Esquire, Inc. ☐ William Esty Co., Inc. ☐ Ethyl Corp. ☐ Evening Star Newspaper Co. ☐ F M A, Inc. ☐ Fairchild Publications, Inc. ☐ Family Circle Magazine ☐ Fawcett Publications, Inc. ☐ Federal Aviation Agency ☐ Firestone Tire & Rubber Co. ☐ Fish Engineering & Construction Co. ☐ Florida Citrus Commission ☐ Fluor Corp. ☐ Foote, Cone & Belding, Inc. ☐ Forbes Marketing Research, Inc. ☐ Foster & Kleiser, Division of Metromedia, Inc. ☐ Foundation for Commercial Banks ☐ Fruit Dispatch Co. ☐ Fuller & Smith & Ross, Inc. ☐ Garrett Corp. ☐ Geigy Chemical Corp. ☐ General Dynamics Corp. ☐ General Electric Co. ☐ General Mills, Inc. ☐ General Motors Corp. ☐ Gillette Company ☐ Grant Advertising, Inc. ☐ Grey Advertising, Inc. ☐ Gulf Interstate Engineering Co. ☐ Hamilton Electro Sales Corp. ☐ Hayden, Stone, Inc. ☐ Health Insurance Plan of Greater New York ☐ Hearst Corp. ☐ Hewlett-Packard Co. ☐ Houston

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